Japanese EFL Learners' Off-line Syntactic Processing Strategies Revisited

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Introduction

As has been examined and considered in Experiment 1, all of the hypotheses were statistically supported and well confirmed. However, the present study, which we will here after refer to as Experiment 2, also needs to be conducted specifically on the basis of the following two distinct and significant aims. These are as follows:

The first aim is to reexamine and reconfirm if the results obtained in Experiment 1 can be applicable to those in Experiment 2 with such different variables as the subjects' learners factors as well as the selected stimulus sentences used as data-collection task items. In Experiment 1, there are 12 stimulus sentences while in Experiment 2, the number was reduced to the eight ones with a view to carrying out further detailed analysis of the results to corraborate with those of of Experiment 1.

The second but more significant aim is to investigate and consider whether there are any significant effects of subsequent discourse contexts on resolution of the ambiguity elicited by a garden path sentence in a single sentence level condition, by comparing the results in Experiment 2 and those in Experiment 3.

The research findings and the results in Experiment 1 were considered and examined in Terauchi (2006).

1. The Four Major Parsing, or Syntactic Processing Principles and Strategies

First of all, in order to conduct an experimental analysis, particularly interlanguage grammar-induced error analysis as well as misuse of theoretical grammar, syntactic principle-based error analysis of the data collected through the elicitation tasks in Experiment 2, the following significant syntactic parsing principles that are required for the present research, will be considered. These major syntactic parsing principles can be described as Minimal Attachment, Right Association, Closure (Early Closure and Late Closure), Theta Reanalysis Constraint.

Pickering (1999:133) refers to the following two fundamental syntactic parsing principles mainly based on the Garden-Path model by citing Frazier's (1979) definition as follows:

The Garden-Path model assumes that initial parsing is principally directed by either:

Minimal attachment. Attach incoming material into the phrase marker being constructed using the fewest nodes consistent with well-formedness rules of the language.

Late closure. When possible, attach incoming material into the clause or phrase currently being parsed.

1.1 Minimal Attachment

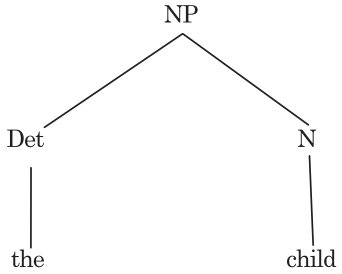
Minimal Attachment can be defined as one of the well-known syntactic parsing strategies based on the syntactic parsing principle, claiming that syntactic parsing, or sentence processing functions in such an efficient way that makes the output structure as simple as possible. In other words, when the syntactic parser, or sentence processor is required to attach 'incoming material' to the tentative structure that is being processed, and then construct a newly built structure, it is 'optimal' to make the number of nodes or branches as small as possible (Frazier & Fodor 1978). Therefore, Minimal Attachment argues that when the

syntactic parser conducts sentence processing, "it is optimal to attach incoming material, or a newly input item to the phrase marker being constructed, with a view to making nodes the fewest to be consistent with the syntactic parsing principle, or the well-formedness rules, of the target language" (Sakamoto 1998:38-39; Abe et al. 1994: 130-131; Abe et al. 1994; Crocker 1999:220-221; Pickering 1999: 131-142). For instance, if a newly inputted item can be interpreted and syntactically processed as either (1) the object of the main clause, or (2) the subject of the subordinate clause, the parser is inclined to select the former interpretation.

The concept of nodes directly comes from the research field of theoretical linguistics; generative grammar. Nodes can be defined as the points where two branches meet when a tree diagram of a sentence is syntactically drawn. See figure 1.

Figure 1.

The tree diagram for "a child"



(Richards & Schmidt 2002:358-359)

As displayed in figure 1, there are three nodes. NP, Det, and N are all on the nodes.

1.2 Right Association

Right Association can be regarded as one of 'the seven syntactic principles concerning sentence processing' claimed by Kimball (1973) as cited in Otsu, (1989); Sakamoto, 1998). This principle explains which structure has the priority of processing when there are two or more possibilities of parsing, or syntactic processing. In other words, it contends that when a newly inputted item can be taken into the partial part of the syntactic, or sentence structure

that has been currently processed and constructed, if there are more than one processing possibilities that will cause syntactic processing ambiguity, it is 'optimal' to attach the newly inputted item to the lowest node. It must be noted here that "optimal" in this case means 'forcing the least burden, or the least cost to the syntactic parser'. For example, as is displayed in Figure 2, when a syntactic parser processes the clause Joe bought the book for Susan to be consistent with the Right Association principle, the interpretation in a can be predicted and selected. On the other hand, the interpretation which can be predicted and selected by Minimal Attachment is the interpretation shown in b, and this interpretation matches to the initial interpretation that native speakers of English prefer to select, when the sentence is presented to the participants without contextual information. In addition, Otsu (1989) proposes "complement preference" principle. He argues that the above-mentioned problem concerning Right Association can be resolved if we add the syntactic principle that "within the same clause, if two possibilities of processing of phrasal category, that is, the possibility of interpretation of the input item as either complement or adjunct, can be predicted and processed, the syntactic parser prefers to select the complement possibility."

Joe bought the book for Susan.

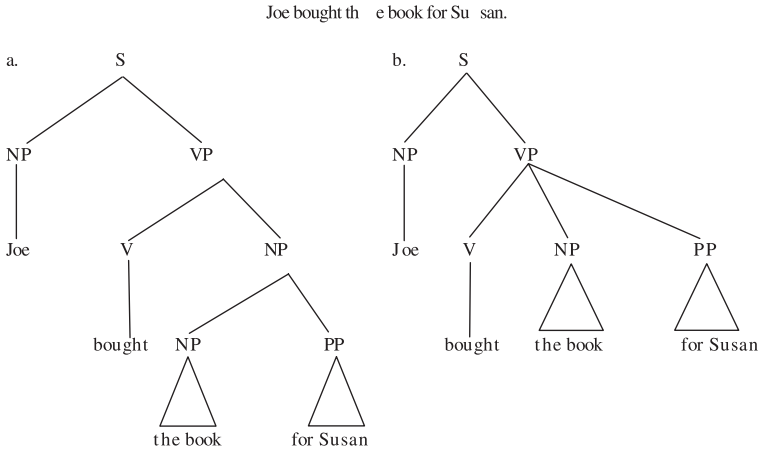


Figure 2. (Based on Sakamoto, 1998: 36)

1.3 Closure

1.3.1 Late Closure

Late Closure is regarded as the syntactic strategy arguing that "in syntactic parsing, attach the newly input item to the phrase or clause that is being currently parsed and constructed." To put it another way, the syntactic parser doesn't attempt to decide the border of a phrase or a clause in an earlier stage, it assumes that the phrase or the clause still continues, or doesn't close. It attempts to go on processing and waits to determine the border until it meets any newly input information that will be conducive to resolve the syntactic and semantic ambiguity. This strategy is required to delay closing the phrase or the clause currently being processed and constructed (Frazier 1979; Crocker 1999: 132-133; Pickering 1999: 220-221, Sakamoto 1998:15-16).

The following two sentences are the well-known examples examined by Frazier & Rayner (1982), who conducted the eye movement-based research to investigate the validity of 'the immediacy principle' of syntactic processing.

(1) Since Jay always jogs a mile seems like a very short distance to him.

(2) Since Jay always jogs a mile this seems like a short distance to him.

(Frazier & Rayner, 1982; Sakamoto, 1998:15)

In (2), since this is put before seems, there occurs no structural ambiguity for the interpretation that a mile is complement of jogs. In (1), however, there occurs the structural ambiguity as to whether a mile should be interpreted as the subject of the main clause or as complement of jogs. To put it more simply, in (1), the syntactic parser doesn't attempt to complete processing when it encounters jogs by utilizing the strategy of "Late Closure". It doesn't close the clause and take as far as a mile into the structure that is being currently constructed. It attempts to interpret a mile as complement of jogs. However, when encounters the next item seems, the parser notices that there is no subject of seems, which never fails to

require reanalysis in parsing. Finally, by attaching a mile, which is being currently processed and constructed as complement of jogs, to the subject of the main clause, it completes the syntactic reanalysis in processing.

1.3.2 Early Closure

Early Closure can be required as the syntactic processing strategy asserting that if it is possible and feasible for the syntactic parser to complete and close a phrase, it will be done as quickly as possible in order to bring the completed phrase to the next processing mechanism as quickly as possible (Kimball 1973).

(3) The horse raced past the barn fell. (Kimball 1973 as cited in Japan Society of Cognitive Science (ed.) 2002:674).

In the case of (3), as the parser has tentatively processed raced, the parser interprets raced as the past form of an intransitive verb of the main clause. When the parser starts to process the subsequent item such as past the barn, it tries to end processing as the sentence The horse raced past the barn. However, when the parser processes the subsequent item fell, it becomes necessary for the syntactic parser to resolve the ambiguity in processing fell, such as whether raced is the verb of the main clause or fell is the verb of the main clause, that is, in order to find out the subject of fell, the parser attempts to make the appropriate reanalysis of the ambiguous sentence structure, and adopts the syntactic analysis that The horse is the subject of fell. It also contends that raced, which the parser interpreted as the verb of the The horse in the initial parsing analysis, can be regarded as the past participle that modifies The horse. In this way, the parser gets rid of the garden path effects and make ambiguity resolution possible and feasible.

1.4 Theta Reanalysis Constraint

Pritchett (1992) defines Theta Reanalysis Constraint as “Syntactic reanalysis which

reinterprets a theta-marked constituent as outside of a current theta domain is costly" (Pritchett 1992:15). The significant point to be noted is that Pritchett (1992:15) also claims that "costly" in this case means that "conscious processing is required." Moreover, it may be safely said that Theta Reanalysis Constraint is almost the same principle as Thematic Overlay Effect in Fodor and Inoue (1995:47) (1998:113).

(4) Without her contributions failed to come in.

In (4), for example, in the initial processing, the parser, on the basis of Late Closure, doesn't attempt to interpret Without her as a complete phrase, but takes in the subsequent contributions and as a result, interprets Without her contributions as a complete phrase. Nevertheless, when the parser attempts to process failed, it recognizes that there is no subject of failed, and attempts reanalysis. When the parser reinterprets the theta-assigned structure Without her contributions as Without her, and then, contributions is the subject of the main clause, the parser "has to consciously attempt to make an appropriate reanalysis in order to satisfy the well-formedness rule", which can lead directly to "costly."

(5) While the boy scratched the big and hairy dog yawned loudly.

(6) While the boy scratched the dog and the girl yawned loudly.

Also, according to the discussion in Ferreira & Henderson (1998), in (6), scratched in the subsequent clause needs to have two arguments, the boy and the dog, and yawned in the main clause, needs to have one argument, the girl. In this way, (6) doesn't assume ambiguity mainly because the thematic processing domains in the main clause and subsequent clause are independent. On the other hand, in (5), the big and hairy dog can be interpreted as the argument of scratched or yawned. Since the thematic processing domain of scratched and yawned overlaps, when the parser interprets the big and hairy dog as the complement of scratched, ambiguity occurs when the parser processes yawned. Therefore, in order to interpret the ambiguous syntactic structure precisely and appropriately, reconfiguration of the

thematic processing domain is needed.

The present study is also conducted in order to elucidate if these four major different types of syntactic parsing principles can be applicable to the Japanese EFL learners' cognitive processes in syntactic parsing and sentence processing.

2 The Principal Aim of Experiment 2

Experiment 2 was conducted in order to explicate the cognitive off-line processes of parsing and resolving the ambiguity principally elicited by garden path sentences, or sentences which are difficult to syntactically process. Out of 12 garden path sentences adopted in Experiment 1, eight significant sentences were chosen as the ones eliciting garden path effects. The rates of correct syntactic analysis, and/or interpretation for each sentence were measured as the product data, and the general tendency of the subjects' cognitive and syntactic processes for analyzing the target stimulus sentences was elicited through a questionnaire as the process data.

3 Research Questions and Hypotheses

The following hypotheses were formed principally on the foundation of the theoretical premises and preceding findings regarding L2 processing research.

Research question 1: What sort of processing has the priority in the sentence-level processing?

Hypothesis 1.1. In a single sentence level condition, priority is, in principle, given to syntactic processing over semantic processing particularly in the initial parsing decision.

Hypothesis 1.2. The subjects who put a priority on syntactic processing are inclined to process, and/or interpret the sentences which are difficult to parse, such as the garden path sentences, more accurately and appropriately than the subjects who put a priority on semantic processing.

3.1 The Theoretical Premise for Making Hypothesis 1.1 and 1.2

Both hypothesis 1.1 and 1.2 are formed specifically on the basis of a principle-based account. In the principle-based account, the comprehension process can be generally required as 'the application of autonomous syntactic principles' (Juffs and Harrington, 1995, 1996; Juffs, 1998a, 1998b, Pickering, 1999, Pickering, et al, 2002; Harrington, 2001, Harrington, 2002). Furthermore, "these principles serve as the exclusive basis for initial parsing decisions, which are subsequently fed to interpretative processes that evaluate and, if necessary, revise the initial parse (Pritchett, 1992). Semantics, frequency, and contextual information are assumed to play no role in initial parsing decisions." (Harrington, 2002, 125).

Research question 2: What kind of processing strategies are adopted for syntactic analysis of a sentence?

Hypothesis 2. The subjects who adopted parallel-distributed processing during syntactic processing have a higher possibility of reaching an accurate syntactic analysis, and/or comprehension than the subjects who adopted serial processing.

3.2 The Theoretical Premise for Mmaking Hypothesis 2

Hypothesis 2 is formed principally on the foundation of a parallel-distributed processing account. In the parallel-distributed processing account, a sentence processor is supposed to compute and consider more than a single particular syntactic analysis in parallel, immediately after it encounters a syntactically and semantically ambiguous sentence such as a garden-path sentence.

That is, to say that in both experviments, but particlarly experiment2, more care

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The description and explanation of this part ranging from Research Questions and Hypotheses are quite similar to those regarding Experiment 1. That is mainly because the same research questions and hypotheses are treated and considered both in Experiment 1 and 2 in order to compare the results between he two experiments.

should be taken with the definition of the meaning of the technical term, 'parallel-distributed processing.' It means the syntactic processing which is performed with consideration of the possibility of using other syntactic processing strategies and/or alternative interpretation in parallel, without adopting the single specific syntactic processing strategy and/or interpretation in the analysis of a garden-path sentence, or a sentence that is difficult to parse. In addition to that, the integrative readers who were able to adopt parallel-distributed processing were assumed to have a higher possibility of achieving accurate and appropriate syntactic analysis, and/or interpretation than the non-integrative readers who attempted to adopt a serial processing. Furthermore, the former type of readers are considered to have a higher possibility of reaching appropriate and correct ambiguity resolution (Block, 1986, 1992).

Research question 3: Where do the readers start rereading a sentence in the case of performing reanalysis of a garden path sentence, or a sentence which is difficult to parse?

Hypothesis 3. The reader who can return selectively to the target part in reanalysis processing are inclined to yield an accurate and appropriate syntactic processing, and/or comprehension.

3.3 The Theoretical Premise for Making Hypothesis 3

Hypothesis 3 is formed mainly on the basis of the information-paced parsing hypothesis claimed by Inoue & Fodor (1995) and Fodor & Inoue (1998). The success in syntactic processing and/or interpretation principally depends on whether the reader is able to precisely select the target parts to be reanalyzed through the initial syntactic analysis of a target stimulus sentence. The target parts spotted in the initial parsing, play a important role of 'mental index' for attempting to perform the efficient and effective reanalysis of a syntactically and/or semantically ambiguous sentence. For example, in a sentence like (1):

(1) I told the boy [the dog bit] [Sue would help him]

If, in the initial syntactic analysis, the proficient reader is inclined to put the 'mental

index' selectively to the target part of 'the dog bit', in the following process of reanalysis, s/he is able to reconstruct a contact clause, or an embedded sentence more easily, in which 'the boy' is modified by the target part marked in the initial syntactic processing.

Research question 4: What are the textual factors impeding correct and appropriate syntactic processing, and/or interpretation?

Hypothesis 4. A central embedded clause causes greater complexity for syntactic processing.

3.4 The Theoretical Premise for Making Hypothesis 4

Hypothesis 4 is formed mainly on the significant effect of a sentence structure's syntactic difficulty and complexity on syntactic processing overload effects.

For example, in the syntactic reanalysis of sentence (1), which has the postpositional modification clause embedded in the central part of the sentence, concretely 'the dog bit', it is claimed that integration cost principally caused by syntactic processing overload effects during the reanalysis frequently results in eliciting cognitive processing breakdown (Pritchett, 1988, 1992; Pickering, 1999; Pickering, et al, 2000; Gibson, 1998, 2000). It is quite evident that the greater the number of syntactically possible combinations a target sentence has becomes, the higher its syntactic complexity is. Specifically, one of the major reasons for the syntactic processing difficulty and complexity in a center-embedded sentence can be clearly explained by Kimball' s syntactic parsing principle of 'two sentences'. For example, let us consider the following two sentences (2) and (3).

(2) [s1 The boy [s2 the girl kissed] slept.]

(3) [s1 The boy [s2 the girl [s3 the man saw] kissed] slept].

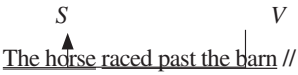
Sentences such as (2) which have a second clause embedded in the main clause are relatively easy to syntactically process. However, a sentence such as (3) which has a third

clause embedded within the second clause is noticeably more difficult to parse. When readers have to conduct a syntactic analysis for two different clauses at a time, they must be able to retain and process these two clauses in their working memory. However, when they have to parse more than the two levels of embedding, or two different sentences at a time, or simultaneously, and the degree of the syntactic complexity increases much more, they become unable to retain and process them. One of the principal reasons for the higher degree of the complexity is closely related to the limited capacity of our working memory (Kimball, 1973, Sakamoto, 1998).

This type of syntactic complexity demands much more cognitive load for a sentence processor. That is because the sentence processor has to compute and consider more than a single possible attachment or association among the strings of words, or fragments of a sentence at a time, or in parallel.

4 The Research Method and Procedure

244 participants were presented the following eight target sentences as data-collection tasks and requested to translate each English sentence into Japanese. They were also requested to write down in Japanese the clues they made use of while they were translating and analyse the phrases and clauses. At the same time, they were required to represent graphically, part of the clues as shown below, or by making use of parentheses and so on, to show the closure of the phrases and clauses, for the purpose of displaying explicitly the syntactic composition of each sentence.



4.1 Examples of Garden Path sentences

For the purpose of considering the general nature of garden path sentences, the following two typical examples are presented. The expected process for each example can be

briefly described.

(1) Without her contributions failed to come in.

In sentence (1), on the basis of the typical types of syntactic processing strategy of 'late closure', the readers usually do not end their own processing procedures by 'Without her', that is, not taking it as a complete phrase. Rather the readers attempt to include the next word 'contributions' and adopt processing, or/and interpretation of closing a phrase such as 'Without her contribution' as a complete clause. However, when their eyes moved on to the target word 'failed', they do not find any subject in the tentative processing, and/or interpretation they adopted in their initial parsing decisions.

Reanalysis should to be attempted as follows; the readers have to decompose the temporarily packaged phrase 'without her contributions' and then repackage 'without her' as a complete phrase assigning another thematic role to it, and reinterpret 'contributions' as a subject of the main clause. This conscious reanalysis demands a higher cognitive load. That is to say, since this reinterpretation requires conscious reanalysis, it will cost much more.

(2) While the boy scratched the big and hairy dog yawned loudly.

Sentence (2) causes the reader to lead directly to garden path effects. On the other hand, the sentence like (3) does not require much more complexity.

(3) While the boy scratched the dog the girl yawned loudly.

According to Ferreira & Henderson (1998), in sentence (3), syntactic and semantic ambiguity does not occur mainly because the arguments taken by the adjacent verbs can be identified with ease. That is to say, as for sentence (3), the verb 'scratched' in the subordinate clause takes both 'the boy' and 'the dog' as its arguments. The verb 'yawned' in the main clause takes 'the girl' as its argument. Since the thematic processing domain in the main clause and the one in the subordinate clause are independent, syntactic and semantic ambiguity does not occur in the sentence.

On the contrary, for the garden path sentence (2), both of the verbs 'scratched' and 'yawned' attempt to take 'the big and hairy dog' as their argument simultaneously. Since thematic processing domains overlap between the two verbs, if the readers attempt to adopt the single particular syntactic analysis, or/and interpretation that 'the big and hairy dog' is the object of 'scratched,' a potential for misinterpretation appears when they encounter another verb 'yawned'. With a view to getting rid of this sort of syntactic conflict, overlapped thematic processing domains need to be reanalyzed.

4.2 Subjects participating in the present study

244 Japanese college students (185 Hosei University undergraduates majoring in economics, English literature, and intercultural communication), 14 Keio University undergraduates, 24 Chiba University undergraduates, 21 Tsurubunka University undergraduates).

4.3 Procedure

For each of eight garden path sentences, the subjects were requested to put marks and translate it into Japanese. The marking they were instructed to make were to use brackets [ ] in order to indicate the beginning and end of a clause, or/and to indicate a phrase with parentheses ( ), or use an arrow to show modifying relationship. After the marking and translation, they were required to reflect on the offline cognitive processes and procedures of their syntactic analyses and write down as concrete a description as possible in Japanese. At the next stage, the questionnaires about the processing strategy they had adopted during processing were offered to the subjects and they were requested to answer in the following three questions: (1) "How did you think about the possibility of syntactic analysis, and/or interpretation ?; (2) What did you do when you recognized your initial syntactic analysis, and/or interpretation as incorrect ?; (3) Where did you start your reanalysis in the sentence ? (For the choices, see appendix B). For the completion of the processing data-collection tasks, about 90 minutes were given to all of the participants in accordance with their self-paced

processing.

4.4 Data analysis:

Translation into Japanese was judged correct or incorrect in a dichotomous scoring protocol, taking into consideration the marking made in the sentence and Japanese translation as indicators of syntactic and semantic analysis.

The descriptions of how they processed each sentence were also analyzed as significant data to explore what sort of information was *principally used. Each subject's degree of reliance on syntactic, semantic or other features in processing of the stimulus sentence was evaluated by the two researchers. The descriptions difficult to categorize were thoroughly discussed between them on a case by case basis.

5 Results and discussion

5.1 Descriptive Statistics

5.1.1 Percentage of Correct in Syntactic Analysis and/or Translation for Each Sentence

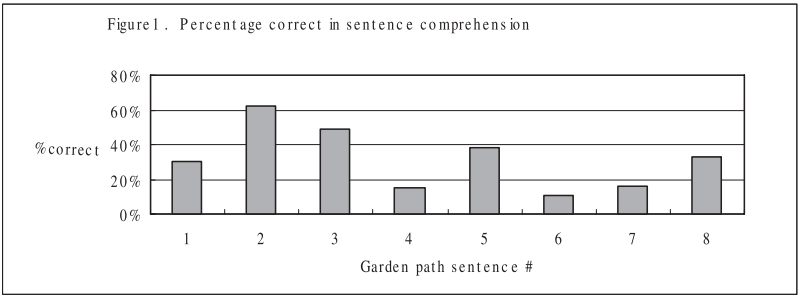
The comprehensibility of each garden path sentence is shown in Table 1 and Figure 1 as the percentage correct in syntactic analysis, and/or translation based on the 244 subjects' responses. The percentage of correct response for each stimulus sentence is displayed in Table 1 and Figure 1. Following each sentence, the expected strategy use for syntactic analysis and/or interpretation is also added.

It can be observed from Table 1 that there is a general tendency for more subjects to reach the correct syntactic analysis, and/or translation for the target stimulus sentences requiring the syntactic processing principles such as 'Late closure' than the ones requiring 'theta re-analysis constraints'. Also the sentences with ' a centrally-embedded clause' were found to be the most difficult to parse and be appropriately interpreted. Analysis of the results for each sentence follows.

Table 1. Sentences used for experiment, processing expected, and percentage of correct answers

No.	the sentences	Expected processing	correct % n=244
1	Without her contributions failed to come in.	L.C, θ	30%
2	While the boy scratched the big and hairy dog yawned loudly.	L.C	61%
3	This was only the beginning of the bad-mouthing robots would receive for the next couple of decades.	L.C, θ	49%
4	The criminal confessed his sins harmed too many people.	L.C	15%
5	As the woman edited the magazine amused all the reporters.	L.C	38%
6	I told the boy the dog bit Sue would help him.	L.C, θ, C	11%
7	The cotton clothing is made of grows in Mississippi.	L.C, θ, C	16%
8	The pitcher tossed the ball tossed the ball.	E.C	33%

In the column of expected processing strategy, 'L.C.' stands for 'Late closure' and 'EC' for 'Early closure'. The θ indicates 'theta reanalysis constraints'. The 'C' stands for a sentence with a centrally embedded clause.



The following sentences such as No.2 and No.5 can be categorized as the ones with the same type of syntactic structure and syntactic feature information. However, as can be clearly seen in Table 1 as well as Figure 1, there is a significant difference in the percentage of correct syntactic analysis between them. *This finding needs to be considered mainly on the basis of the lexical information regarding the head and the knowledge of the world, and so on other than syntactic feature information (Kawasaki 2005:104-106).

In No 2: "While the boy scratched the big and hairy dog yawned loudly." (61% correct) and No.5: "As the woman edited the magazine amused all the reporters." (38%), the focal point concerning the syntactic processing of the two clauses was whether the subject in the main clause was regarded as the object of the verb in the subordinate clause, or not. To be more precise, in No.2 with a rather high correct percentage (61% correct), one of the most significant syntactic processing problems was whether 'the big and hairy dog' was to be interpreted as the object of 'scratched' or the subject of 'yawned', and also mainly depended on a particular syntactic analysis on the basis of one of the principal syntactic processing principles of 'closure'. That is, in the initial parsing decision, the big and hairy dog is attached as the object of scratched to the sentence structure being currently constructed. After yawned is encountered, there occurs a sort of 'tug of war' (Fodor & Inoue, 1998:114). Specifically, there occurs syntactic parsing ambiguity that the big and hairy dog can be interpreted either as the object of scratched or the subject of yawned. What has to be noticed here is that scratched can be interpreted either as a transitive verb or an intransitive verb, if scratched is required as a transitive verb, syntactic processing breakdown elicited by garden-path effects never fail to occur.

No. 3: "This was only the beginning of the bad-mouthing robots would receive for the next couple of decades." (49%), No. 7: "The cotton clothing is made of grows in Mississippi." (16%), and No. 6: "I told the boy the dog bit Sue would help him."(11%) can be regarded as similar types of the garden-path sentences that require the reader to recognize a contact clause embedded in each sentence. In each sentence, since a clause is embedded, the syntactic processing overload would have elicited misanalysis in parsing, and/or misinterpretation of the three target sentences. For the reason above, only the few subjects were able to yield the correct syntactic analysis, and/or interpretation. It would have caused the syntactic processing

overload to parse double or triple predicate forms in a sentence, which required the subjects to add incoming material to the tentative syntactic structure that was currently being processed and constructed. Although the syntactic processing principle of 'late closure and theta-role reanalysis constraints' were required for all the three sentences, No.3 was less difficult with a higher correct ratio (49%) than the other two sentences. In comparison with the similar type of sentences No.7 (16%) and No.6 (11%), the significant difference might have come from the embedment of the clauses in the middle of the sentences. In No.3, the embedded clause was not in the middle of the sentence but additional clause following the antecedent as a contact clause. This type of difference in the position of the embedded clause might cause the significant difference in difficulty.

In No.7, the antecedent 'the cotton' was regarded as the subject of the main clause, and in No.6, the object of the embedded clause 'the dog bit' was 'the boy' that is also required as a direct object in the main clause. An explanation for no.6 being, as the most difficult one, can be founded in the syntactic processing principle of 'two sentences' (Kimball,1973, cited in Prichett,1992), that is, if two clauses are embedded in one sentence, it is likely to cause the reader to misinterpret it. Therefore, it is assumed that not many of the subjects could reach the most appropriate syntactic analysis, and/or interpretation. It would have caused the processing overload to parse double or triple predicate forms in a sentence, which required the reader to add incoming material to the tentative syntactic structure that is currently being processed and constructed.

No. 8:"The pitcher tossed the ball tossed the ball." (33%) can be defined as a typical garden-path sentence (Bever, 1971) requiring the reader to conduct a higher cognitive syntactic analysis for the target part including postpositional modification with a past participle verb. In the case of syntactic processing of this sentence, it is necessary to apply the syntactic principle of 'early closure' which requires the reader to judge 'tossed' to be a past participle verb in the initial syntactic analysis. In terms of a serial processing, when the reader reaches the target part "The pitcher tossed the ball", s/he might have interpreted it as S+V+O sentence until s/he encounters the second 'tossed'. Then s/he had to reanalyze the sentence and as a result, recognized that the first 'tossed' is a passive voice modifier to 'the

pitcher' with a view to achieving successful resolution of ambiguity. In other words, in the case of parsing this garden-path sentence, until reaching the ball, the reader interpreted tossed as an active past tense verb. To sum up, if the syntactic principle of 'early closure' is applied to the stimulus sentence, the following sentence structure is constructed in the initial syntactic analysis.

(12a) [S [NP The Pitcher] [VP tossed the ball]]

When tossed the ball at the right edge is encountered, the reader realizes that this second tossed the ball is the VP of this target sentence. And at the next stage, the reader recognizes that The pitcher tossed the ball is the subject of this sentence, and that tossed is the active past tense form of the transitive verb toss which takes double objects as the subsequent element and *modifies The pitcher as the ball does.

From another point of view, the meaning to be reached is closely related to a specific situation in baseball, therefore, it might have been very difficult for some of the readers to draw a proper 'situation model' from what the sentence implied. The existence or nonexistence of some sorts of content schemata, or background knowledge about baseball might have been influential as a significant determining factor. One of the possible and predictable reasons for fallacious syntactic analysis, and/or interpretation is that the participants had an insufficient quantity of content schemata concerning baseball.

Other readers seemed to have taken the existence of two 'tossed' as emphasis or an emphatic expression by repetition such as the sentence that the pitcher tossed the ball and tossed the ball. In this way, the cognitive cost of syntactic and semantic processing seemed to spend a more substantial amount of cognitive load and caused garden path effects.

In No.1:"Without her contributions failed to come in." (30%), most of the subjects failed to treat the noun 'contributions' as the subject of the sentence. They appeared to have the difficulty in breaking apart the phrase 'her contributions' elicited principally by the parsing principle of 'theta reanalysis constraint.' The cognitive load to consider alternative syntactic analysis, and/or interpretation was so much challenged that in this case, syntactic processing might have broken down. Therefore, there was a need of changing, or revising the first-pass

analysis such as “Without her contributions”. However, in that it is conducive to violating theta re-analysis constraints, or the parsing principle of ‘fixed structure’, it might cost more than readers’ meta-cognitive abilities to modify the initial syntactic analysis from “Without her contributions” to “Without her”, i.e. shortening of the governing domain of ‘without’. That is, in No.1, the sentence processor, on the basis of ‘Late Closure’, doesn’t attempt to interpret without her as a complete phrase, and takes in the subsequent noun; contributions and interprets without her contribution as a complete phrase in initial parsing decision. Nevertheless, when the processor reaches failed, it recognizes that there is no subject of failed, and then attempts to conduct a syntactic reanalysis for the problematic part in order to find the subject of failed and resolve the syntactic ambiguity. As a result, when the processor attempts to reinterpret theta-assigned structure Without her contributions as without her, it comes to regard contributions as the subject of the main clause for the purpose of achieving a successful resolution of ambiguity. However, in this case, the processor has to consciously attempt to make an appropriate reanalysis for the problematic part with a view to satisfying the well-formedness rule, which can lead directly to “costly” processing (Pritchett (1992:15).

In No.4:“The criminal confessed his sins harmed too many people.”(15%), the verb in the subordinate clause is harmed, which can be considered to be either an active past-tense verb or a past participle. Moreover, the word strings of ‘The criminal confessed his sins harmed’ can be understood either S+V [S+V] or S+V+[O+p.p]. In this case, *the transitivity of the two verbs of sentence like (6) might have confused the readers more than the former two sentences with an intransitive ‘be’ verb. That is to say, one of the predictable reasons for this type of syntactic complexity is closely related to the object/complement (or “NP/S) ambiguity. For instance, after a sentence processor encounters the criminal confessed his sins, it initially attempts to view the clause as a syntactically ambiguous one, in that the noun phrase his sins might be the object of confessed or the subjects of a complement clause. In this case, the object analysis demands the postulation of fewer nodes than the complement analysis, therefore, on the basis of the syntactic processing principle such as ‘minimal attachment’, it is adopted in the initial parsing decision. However, after harmed is encountered, it becomes quite evident that the object analysis cannot be possible, and/or plausible, therefore, reanalysis is needed in order to achieve the most appropriate syntactic analysis (Pickering, 1999; 33).

These types of syntactic feature information frequently lead directly to a syntactic processing breakdown caused, and/or elicited by the 'garden path' effects. In other words, the processor's cognitive load was heavily challenged to consider which possibility to find out and/or to select other parsing possibilities.

5.1.2 General Tendencies of Syntactic Processing

Table 2 shows the summarization of the answers to the questionnaire about the interpretation process for each sentence, which was reflectively elicited right after the task of processing each sentence.

Table 2 The processing tendency for each sentence (n=244)

	correct1 answers	processing route		processing timing		returning position in reanalysis			strategic reliance		
		serial	parallel	imme-diate	delayed	beginning	selective	backtrack	syntactic	semantic	unfixed
Sent. 1	30%	86%	10%	43%	53%	60%	30%	5%	83%	8%	7%
Sent. 2	61%	73%	24%	50%	46%	57%	30%	6%	84%	7%	7%
Sent.3	49%	75%	15%	43%	46%	50%	32%	7%	68%	8%	18%
Sent.4	15%	73%	21%	41%	51%	53%	32%	5%	82%	6%	9%
Sent.5	38%	69%	25%	41%	50%	54%	28%	7%	76%	8%	14%
Sent.6	11%	73%	17%	43%	47%	48%	32%	8%	73%	9%	13%
Sent.7	16%	80%	11%	41%	50%	50%	32%	6%	64%	13%	18%
Sent.8	33%	67%	20%	35%	50%	51%	27%	6%	60%	10%	20%
Total	32%	75%	18%	42%	49%	53%	30%	6%	74%	9%	13%
Data Missing		7%		9%		11%			4%		

Concerming the route of processing, 75% of all the subjects chose serial processing and only 18% chose parallel-distributed processing. Sentence No.1 had the highest ratio of serial processing (86%) with 30 % correct answers. The next highest was the sentence No.7 (80%) with 16% correct. So the high ratio of using serial processing seemed not to have yielded

better results. Regarding parallel processing, No.5 had the highest rate of parallel processing, 25%, with the third highest correct answers, 38%. No.2 had the second highest rate of parallel processing, 24%, with the highest ratio of correct answers, 61%. So the use of parallel processing seemed to have resulted in better interpretation.

As for processing timing, 49% chose delayed-distributed processing and 42% selected immediate processing. No.8 had the lowest rate of immediate processing. When the complexity of the meaning conveyed in the sentence is considered, it is not surprising that the readers tended to have delayed interpretation.

Regarding the position for reanalysis, 53% chose the beginning of a sentence, 30% chose the selective point, 6% chose backtracking. No.1 and No.2 had rather higher rates of returning to the beginning; this variable seemed not to have strong effect on arrival at the correct interpretation.

Concerning processing strategy, 74% put the priority on syntactic information, 9% on semantic information, and 13% on unidentified information. Among the sentences using highest rate of syntactic strategy, No.2 (84%) had the highestrate of correct answers, 61%, but No.1 (83%) had a higher correct rate. Sentence No.4 with 82% syntactic strategy rate , had very low correct rate, 15%. From these results, it can be said that relying heavily on syntactic processing did not necessarily lead to a correct answer.

The notable tendency of Sentence No.5 exhibites the third highest correct answers is the highest ratio of parallel-distributed processing (25%).

To give an overview of Table 2, the general tendencies of the subject responses were as follows: the predomnant processing route was serial; processing timing was mixed with a light tilt toward delayed processing; the most freguent position for reanalysis was at the beginning of the sentence; and there was heavy strategic reliance on syntactic information. It can be said that these tendencies did not *improve the chances for the success in interpretation since the rate of correct answers as a whole was no more than 32%.

5.2 Statistical Analyses

5.2.1 General Tendency of Syntactic Processing

In order to investigate the relationships between the facfors in sentence processing, Pearson's product moment correlation coefficient were obtained between, the score of correct interpretation and the responses to the questionnaire. Table 3 shows the result to the analysis.

Table 3. Pearson's product moment correlation coefficients based on the number of correct interpretation and response to the questionnaire (n=244)

	processing route		Processing timing		returning position in reanalysis			strategic reliance		
	serial	parallel	imme-diate	delayed	begin-ning	selective	back-track	syntax	semantic	unknown
inter-pretation	-.004	.042	.013	.111	.10	.049	.01	.287 (**)	-.033	-.231 (**)
serial			.149 (*)	.012	.240 (**)	-.071	-.038	.061	.001	-.004
parallel			-.094	.126	-.154 (*)	.191 (**)	.106	.133 (*)	-.056	-.117
imme-diate					.01	.062	.131 (*)	-.021	.047	-.022
delayed					.180 (**)	.067	-.083	.148 (*)	.023	-.077
beginning								.037	.143 (*)	-.027
selective								.113	-.077	-.044
backtrack								-.052	.018	-.041

two-tailed test ** p<.01, * p<.05,

A weak but significant positive correlation was found between correct interpretation and syntactic strategy (r=.287,p<.01). A significant negative correlation was found between correct interpretation and unclear strategy use (r=-.231,p<.001), which means the reader who did

not know which strategy they relied upon was less successful in interpretation. This seemed to be related to the issue of metacognitive awareness of on-going processing.

Although it is not directly relevant to the interpretation, it was observed that serial processing had a weak correlative relationship with immediate processing at 5 % significance (r=.149), and with returning position of 'beginning' with less than 1% significance (r=.240). From these finding it can be said that the reader who tended to adopt serial processing were likely to process immediately, and in reanalysis return to the beginning of the sentence. When parallel processing was focused on, it had a weak correlation with 'selective' returning in reanalysis (r=.191, p<,01) or with syntactic strategy (r=.133, p<.01). This results show that the readers who took selective reanalysis relied on syntactic information more. From the viewpoint of syntactic strategy reliance, it also had a correlation with delayed processing (r=.148, p<.05) and with returning position of 'beginning' (r=.180, p<.01), from which we could say that the readers were supposed to reanalyze from the beginning relying more on syntactic information.

5.2.2 General Tendencies according to Proficiency Groups

In order to investigate the tendencies of processing according to proficiency level, the subjects were divided into three proficiency groups based on the number of correct answers out of eight garden path sentences. The High group consists of the subjects with 6 points and more, the middle group with 3 to 4 points, the low with 1 to 2 points. Since the number of the subjects in the groups were not balanced (High, N=37; Middle N=71、Low, N=103、No points, N=33), the subjects with no correct answers were omitted.

Through the use of one-way Analysis of Variance, average scores in each group were compared for every processing item, based on the three proficiency groups as an independent variable. Table 4 indicates the average scores and the results of the statistical analysis (See also Figure 1). Significant differences were found in the syntactic processing in the mean scores among the three groups (F(2,208)=6.947, p=.001). In order to identify the statistically significant relationship between the groups, the Tukey method was used for the post hoc analyses. The result indicated that the High group had significantly higher mean score than the Low group (p<.01), and so did the Middle group to the Low group (p<.05). This meant that

the low proficiency group relied less on syntactic information. It was assumed that the readers with low proficiency in English could not rely on their insufficient grammatical knowledge.

Table 4. ANOVA test results based on the Mean score for each proficiency group

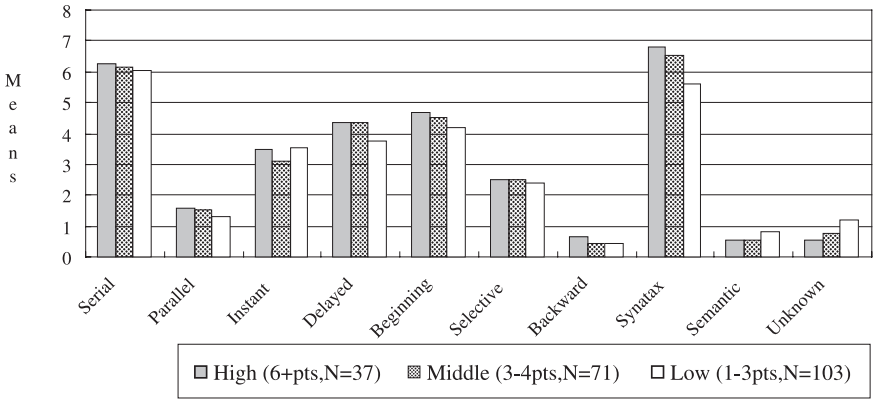
statistical description					ANOVA results	
		N	M	SD	F-value	p-value
correct interpretation	High	37	5.95	0.88	843.097	0
	Mid	71	3.44	0.499	H>M>L**	
	Low	103	1.47	0.501	d f =2,208	
serial	High	37	6.24	1.906	.158	.854
	Mid	71	6.13	1.843	n.s.	
	Low	103	6.03	2.22		
parallel	High	37	1.59	1.922	.489	.614
	Mid	71	1.52	1.698	n.s.	
	Low	103	1.31	1.76		
Instant	High	37	3.49	2.642	.52	.595
	Mid	71	3.11	2.589	n.s.	
	Low	103	3.52	2.811		
delayed	High	37	4.38	2.628	1.389	.252
	Mid	71	4.38	2.685	n.s.	
	Low	103	3.75	2.841		
beginning	High	37	4.68	2.667	.642	.527
	Mid	71	4.49	2.341	n.s.	
	Low	103	4.17	2.677		
selective	High	37	2.49	2.388	.087	.917
	Mid	71	2.51	2.184	n.s.	
	Low	103	2.37	2.33		
backtrack	High	37	0.68	1.27	.919	.401
	Mid	71	0.42	0.966	n.s.	
	Low	103	0.43	0.956		
syntax	High	37	6.78	1.813	6.947	.001
	Mid	71	6.54	1.697	H>L**, M>L*	

	Low	103	5.62	2.192	d f =2,208	
semantic	High	37	0.57	1.214	1.222	.297
	Mid	71	0.56	0.874	n.s.	
	Low	103	0.81	1.229		
unknown	High	37	0.54	1.043	3.608	.029
	Mid	71	0.77	1.354	H <L*	
	Low	103	1.22	1.703	d f =2,208	

*= p<.05, **= p<.01, n.s.= not significant

Another variable that showed a significant difference among the groups was the 'unknown strategic reliance' (F(2,208)=3.608, p=.029). The source of the significance was the difference between the High and the Low groups with less than 5% significance level. This result indicated that the readers with low proficiency could not identify their use of strategy, is was in accordance with previous literature.

Figure 1. Average scores of processing data in three proficiency groups



6 Verification of Hypotheses

Hypothesis 1.1: In a single sentence level condition, priority is, in principle, given to syntactic processing over semantic processing particularly in the initial parsing decision.

From the descriptive data shown in Table 2, it was obvious that syntactic processing (74%) overwhelmed the two other strategies. Therefore the hypothesis 1.1 was supported.

Hypothesis 1.2: The subjects who put a priority on syntactic processing are inclined to process, and/or interpret the sentences which are difficult to parse, such as the garden path sentences, more accurately and appropriately than the subjects who put a priority on semantic processing.

Although the percentage of the correct answers was low in total, the correlation between the strategic reliance on syntax and correct interpretation showed a significant positive relationship(see Table 3, $r=.278$, $p<.01$). Since the correct translation had the negatively correlated relationship with semantic information ($r=-.231$, $p<.01$), it can be said that relying on syntactical information is the principal for garden path sentence analysis. The hypothesis 1.2 was supported.

With a view to verifying the differences between the averages of syntax-based strategy for the three groups distinguished by rate of successful translation and/or complehension, a test of analysis of variance (ANOVA) was practiced. According to the results the differences shown in Table 4, the difference among the three groups was statistically significant ($F(2,208) = 6.947$, $p<.01$). It was also verified that there were significant differences between the High vs. the Low ($p<.01$), and the Middle vs. Low ($p<.05$) groups.

Hypothesis 2: The subjects who adopted parallel-distributed processing during syntactic processing have a higher possibility of reaching accurate syntactic analysis, and/or comprehension than the subjects who adopted serial processing.

By Pearson's correlation coefficient (Table 3), when the number of correct answers and the number of responses indicating parallel processing were counted, no significant correlation was reached ($r=.042$, n.s.). It was obvious from Table 4 that the difference among

the three groups showed no significant differences（F（2, 208）＝.489, n.s.）either. From these results, the hypothesis 2 was not well supported. Therefore, further research needs to be conducted in order to elucidate if the effects of adopting parallel distributed processing on syntactic processing does not lead to proper and appropriate analysis, or interpretation.

Hypothesis 3: The readers who can return selectively to the target part of a sentence in reanalysis processing are inclined to have a higher possibility of achieving an accurate syntactic analysis, and/or comprehension.

From correlations obtaimed in this study, the relationship between the correct Japanese translation was not statistically signiticant for selective reanalysis (r=.049, n.s.). Nor were the differences proven to be statistically significant between subjects grouvped by levels the averages of proficiency (F（2,208）= .087, n.s.). Based on these results, the hypothesis was not supported. A possible cause of this result was the overall lower level of proficiency of the sample in Experiment 2 than those in Experiment 1. Therefore, further research needs to be conducted in order to elucidate if the effects of adopting selective reanalysis in syntactic processing does not lead to proper and appropriate syntactic analysis, or interpretation.

Hypothesis 4: A central embedded clause causes greater complexity for syntactic processing.

The target sentences for this hypothesis were No. 6 and No. 7. The percentage of correct answers was as low as 11% for No. 6, and 16% for No. 7, which were the lowest among the sentences. Tthe hypothesis was well supported by the results in this study.

7 Conclusions and Discussions

In the present study, the general tendency for the priority of adopting syntactic processing was well recognized in the natural course of syntactic processing, or interpretation of garden path sentences. In addition to that, it can be concluded from these research findings that the differences in distinct type and degree of syntactic complexity and ambiguity of the

target sentences can have a significant effect on Japanese EFL learners' cognitive processes in syntactic and sentence processing of isolated sentences. Further experimental research needs to be conducted for the purpose of elucidating the general tendency and possibility of the priority for adopting the different types of syntactic processing and reanalysis strategies in relation to the difference in Japanese EFL learners' proficiency and other learners' factors.

Moreover, the possible and predictable factors eliciting misanalysis, or misinterpretations of the garden path sentences are as follows:

(1) violation of prioritizing syntactic processing in the cases of early and late closure as well as theta reanalysis constraint.
(2) effects of participants' interlanguage regarding the syntactic knowledge and rules appeared in the process of constructing.
(3) transfer of L1 syntactic rules into the processing of garden path sentence. For example, since Japanese can be regarded as a null-subject -based language, or one with pro-drop rules, some of the participants prefer to adopt a syntactic analysis and interpretation that ungrammatical sentence without subject is acceptable.
(4) degree of preference in choosing collocation pattern. For example, some subjects may prefer to take the pronoun 'her' as possessive case as a default value, while others may put the default value as objective case. Such preference, or default value, may be constructed on the basis of frequency of how much an individual participants encountered a certain pattern of word strings.

These significant points need to be further elaborated and controlled for in later research.

8. Implication for Later Research and Experiments

The above-mentioned significant issues should be thoroughly considered, and revised. In addition to that, further experimental research is essentially the purpose of elucidating whether there are significant effects of prior or subsequent discourse contexts on proper parsing of the complexity, as well as the ambiguity resolution of, garden path sentences.

Experiment 3 has to be conducted on the foundation of more plausible and valid research methods in order to compare the results in Experiment 2 with those in Experiment 3.

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